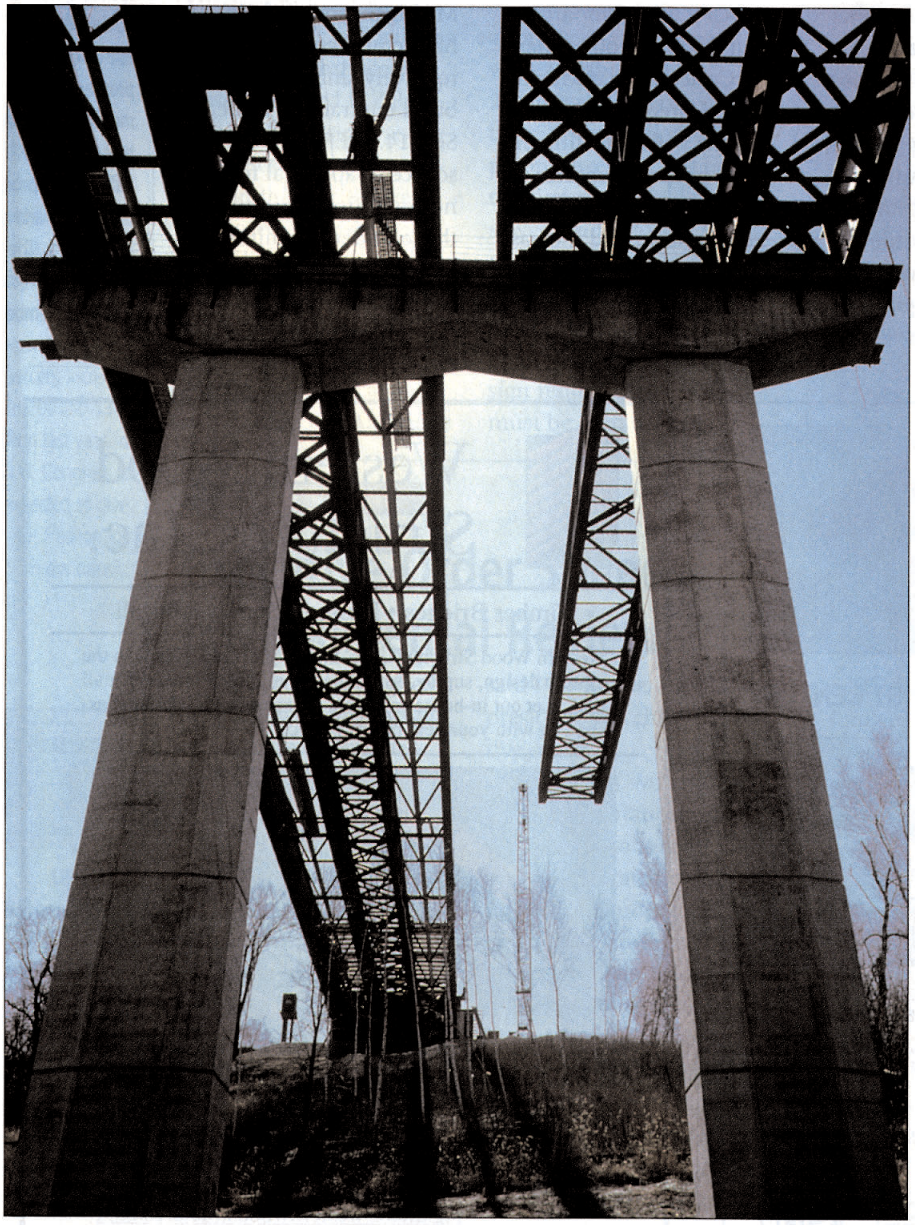
Green Giant

Environmental mitigation leads to launched erection of steel I-girder bridge

By David Rogowski, P.E.

When it comes to bridge design and construction, it's seldom just mathematical and structural requirements that determine the ultimate solution. Very often, external factors — whether it be public opinion, land-use issues, or available funding — steer the structure's course.



Incremental launchings of the spans took four months to complete. By using weathering steel and simple bridge components, the structure does not overpower or visually detract from the river valley.

The environment was the leading factor shaping the final appearance and construction of one of Iowa's newest highway bridges — the U.S. 20 Iowa River Bridge, situated in the heart of the environmentally sensitive and protected Iowa River Greenbelt.

For years, the reconstruction of four-lane U.S. 20 remained incomplete through Hardin and Grundy counties in central Iowa. Mandates to preserve the Greenbelt, which runs along a 50-mile stretch of riverbank, resulted in two-lane blacktop roads weaving through small communities. The Iowa DOT's goal was to widen and straighten the highway to provide safer and faster passage to motorists traveling the 200-mile distance between Dubuque on Iowa's eastern border to Fort Dodge due west. The challenge was finding a way to bridge the 10-acre Greenbelt valley with the least impact to its native plant and animal species and archaeological treasures.

When the $20.5 million bridge opens to traffic later this year, those who drive its 1,630-foot length will be pleased to find 15 miles and 30 minutes have been trimmed off their previous commute. Those who canoe under the structure will scarcely notice its existence. But those who orchestrated the carefully sequenced launch of ten 302-foot spans of structural steel will marvel at this accomplishment.

Collaboration and innovation

HNTB Corp., Kansas City, Mo., design and construction consultant for the project, worked closely with IaDOT and FHWA to meet multiple objectives in designing the bridge. Although environmental sensitivity was the overriding design directive, economics followed closely.

Upon final selection of the site in 1996 (the culmination of more than 25 years of planning), HNTB studied six bridge designs ranging from concrete and steel arches to concrete box girders to steel I-girders. Multiple erection methods were evaluated as well. Because IaDOT was not seeking a signature bridge design, several options were quickly eliminated. After evaluating each for cost feasibility, environmental impact, and aesthetic appeal, HNTB recommended a launched steel I-girder design, with longer spans to reduce the number of piers needed and minimize visual obstructions at river level. Weathering steel material was selected for two reasons: It blends seamlessly into the natural surroundings and eliminates the need for future painting.

Erected as two parallel 39-foot-wide deck structures, the bridges consist of five 302-foot spans and one 60-foot precast concrete jumpspan at each end of the bridge. The deck structures are supported on six cast-in-place reinforced concrete piers, up to 120 feet tall, and two end abutments. Each steel deck structure consists of a system of four 11-foot-long, 4-inch-deep I-girders spaced at 12-foot centers. Although steel pile foundations would have been less costly, the two central piers are supported on 8-foot-diameter drilled shafts to minimize footing activity near the river banks. The outer piers and abutments are supported by 100-ton piles driven to bedrock. The 1,630-foot bridge will carry traffic approximately 137 feet above the Iowa River.

Steel I-girders readied for launch from a 15-foot-deep, 600-foot-long pit excavated behind the bridge's east abutment.

A sealed drainage system collects stormwater from the bridge deck. A pair of 14-inch-diameter pipelines run the length of each structure and carry runoff to a storage basin near the west abutment. The basin collects runoff and allows solid materials, primarily silt and roadway salt, to settle out. The materials then can be dredged and removed from the site in the future.

To protect three mussel species, the project team had to keep construction equipment out of the river and construct a containment system to prevent fluids in the river, including accidental fuel spills, hydraulic oil from machinery hoses, and even natural water that emerged from constructing drilled shaft foundations through lenses of water above the rock formations.

Also, a number of different zones onsite required clearing procedures and environmental protection. The contractor had to construct minimal access paths into the valley, which were removed and restored after completion. A temporary crane mat was constructed in the east river bottom above the high-water elevation to minimize the risk of damage to both the environment and the contractor's equipment.

Span construction

Because equipment access was limited and environmental restrictions were strictly enforced, HNTB engineers pushed forward with the launched erection sequence as the method of construction. While it had never been employed for a long-span I-girder bridge made up of nearly 10 million pounds of structural steel, the incremental launching technique had been successfully used to erect more torsionally stable concrete box structures in Europe, as well as a smaller steel box girder railroad bridge in the United States. Contractor Jensen Construction, Des Moines, Iowa, and erection engineer Ashton Engineering, Davenport, Iowa, were up to the challenge. Jensen modified some of the erection sequence's roller and guidance systems to better suit its schedule, available equipment, and materials. The customized equipment pushed approximately 5 million pounds of steel per bridge.

After launching all 302-foot spans, workers began construction of the bridge deck.

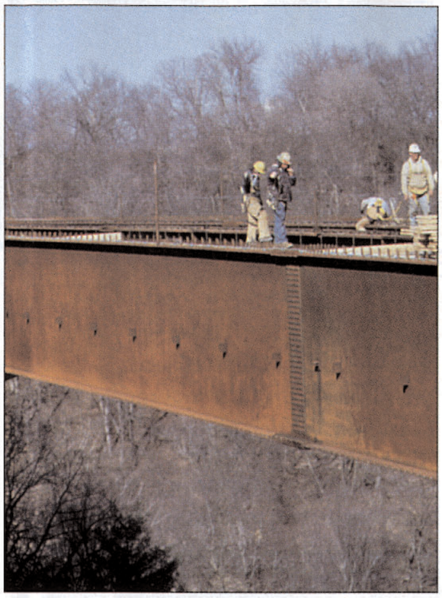
Construction of the substructure elements began in August 2000, and preparation of a 15-foot-deep, 600-foot-long launching pit behind the east abutment was completed in November 2000. The launching pit, dug beneath what would later become the approach roadway, was used to construct a number of temporary pile bents where sections of the I-girder superstructure would be assembled on rollers and later pushed incrementally across the piers.

Steel assembly for the eastbound bridge began in June 2001. After Jensen completed the steel erection on each span in the launching pit, including all diaphragms and lateral bracing, the steel was launched downhill along a 0.64 percent grade, being pushed by hydraulic pistons toward the west abutment at a pace of approximately 1 fpm.

After some adjustments were made to the steering mechanism to ensure the spans were guided in the proper alignment, the launching process moved full steam ahead. A temporary "launching nose" was attached to the front of the leading span to guide its placement and reduce deflection of the 302-foot cantilever. Temporary roller bearings placed on the bridge piers assisted with the process of rolling the sections across the valley.

Following the launch of the eastbound bridge, the contractors' equipment was moved to initiate an identical launching of the parallel westbound bridge in January 2002. Favorable weather conditions aided the project schedule, and crews completed the launch of the 10th and final span in late March. The launching skid was removed, and the full length of the superstructure was jacked up to remove the rollers and then jacked down onto permanent bearings on the piers.

Doug McDonald, IaDOT's resident construction engineer for the project, noted that the daily interaction and close



Although these workers stand out against the Iowa River Greenbelt background, the bridge materials and form were designed to blend with its natural surroundings.

collaboration among all parties — IaDOT, HNTB, and Jensen — helped the highly complex construction process proceed on a nearly year-round basis. Even in the final months of the bridge's construction, the project team employed additional customized engineering solutions. To build the bridge's concrete deck, the team developed a method to eliminate the usual ground operation of a crane. A custom-designed mobile crane was constructed to run the length of the girders to assist with installing deck drain piping.

Gaining recognition

Ongoing paving of U.S. 20 at the bridge's east end will delay its opening until mid-summer 2003, but already the bridge is capturing attention. The project has received a Grand Conceptor Award from the American Council of Engineering Companies of Iowa and a Grand Award from the Consulting Engineers Council of Missouri. It also was recognized by FHWA for engineering excellence in pursuit of environmental sensitivity. In addition, the project is a finalist in the Construction Innovation Foundation's NOVA awards program, which recognizes significant advances in the construction industry.

As the project team is being honored for its ability to address significant design and construction challenges, the bridge is already blending with its natural surroundings. "As you view the bridge today, you see the trees growing right alongside it," McDonald said. "Once we fully restore the project site, the bridge breaking out of the trees will be the only visual cue that this engineering and construction feat ever took place."

Meanwhile, other projects in other places will benefit from the U.S. 20 bridge's erection advances. Recently, a steel I-girder bridge in West Virginia was launched, while another bridge in Ohio is under design and scheduled to launch in 2005. ■

David Rogowski, P.E., served as project manager and engineer for the U.S. 20 Iowa River Bridge. He has worked for HNTB, Kansas City, Mo., for 14 years and has helped design numerous unique, large-scale bridge projects in the central United States.